"STUDY OF ANTIOXIDANT CAPACITY IN SOME LEAFY VEGETABLES AND UNDERGROUND MODIFICATIONS OF JHARKHAND"

A Synopsis

In Fulfilment of Conditions Governing

Candidature for The Award

Of

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(Department of Chemistry)

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THE SYNOPSIS

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STATE OF THE ART

In today's world, human health has become more important than ever before. People are increasingly prioritizing fitness, beauty, and nutrition, leading to an increased focus on diet and its impact on health. A new, positive perspective on diet and health is emerging, emphasizing the benefits of "functional foods" - those that provide additional health benefits beyond basic nutrients like vitamins, minerals, and proteins. These foods have the potential to prevent or delay chronic diseases while also fulfilling our basic nutritional needs [1] . When it comes to antioxidants, there are two categories - Natural antioxidants like Vitamin C and E, β-carotene, anthocyanins, lutein, etc., and Synthetic antioxidants like Butylated hydroxytoluene (BHT), Butylated hydroxy anisole (BHA), etc.

However, researchers are now increasingly interested in finding naturally occurring antioxidants in our food as a safer, healthier alternative to synthetic options [2]. The Government & Research Institutions in India are keeping an eye on the nutritional values, antioxidant capacity, and the production of some antioxidant sources, of which a few references are given below. Focusing on the region of our state Jharkhand, there are several varieties of vegetables rich in antioxidants like Lycopene, β-Carotene, Ascorbic acid, etc., the common sources being Tomato and Carrot. The regions of tomato production in the state are Ranchi, Lohardaga, Hazaribagh, Godda, Chaibasa, Deoghar. The varieties of Tomato being produced in the state are Pusa Ruby, Pusa Gaurav, Pusa Rakshit, Swarna Lalima, Kashi Amul, Swarna Naveen, Golden Estate, Arka Samrat, Swarna Sampada, etc.

According to the annual reports of Indian Council of Agricultural Research (ICAR) & Indian Agricultural Research Institute (IARI), two of the main vegetable sources of antioxidants – Tomato and Carrot production in Jharkhand in recent years are 265.26, 271.04, 277.19, 276.05, 288.39 tonnes and 10.01, 11.3, 11.7, 23.38, 22.51 tonnes in 2017-18, 2018-19, 2019-20, 2020-21, 2021-22, respectively [3].

Table 1: Production of Tomato and Carrot in Jharkhand during recent years.

Production(in tonnes)		
Year	**Tomato**	**Carrot**
2017-18	265.26	10.01
2018-19	271.04	11.3
2019-20	277.19	11.7
2020-21	276.05	23.38
2021-22	288.39	22.51

In 2018, IARI reported tomato hybrids H367(90 t/ha), H248(85 t/ha), H259(72 t/ha), H249(70 t/ha) and DTPH 60(1.56 t/100 m^2) with Lycopene content 5.8 mg/100g [4].

In 2019, IARI reported tomato hybrid H337(60.3 t/ha), DTPH 60(15.6 q/100m^2) with Lycopene content 5.8 mg/100g. Among Carrot hybrids, DCatH 5396 total carotenoids 75.57 µg/100g, DCatH 9834 Lycopene 43.76 µg/100g, DCatH 5322 β-carotene 18.65 µg/100g, DCatH 5326 lutein 1.47 µg/100g reported [5].

In 2020, IARI identified 2 promising cherry tomato selections. Pusa Rakshit (DTPH 60) yield 16.5 q/100 m^2 with lycopene content 6 mg/100g. Pusa Unnat brinjal(DBHL 211) contains higher flavonols 6.98 mg/100g and ODH phenols 7.89 mg/100g [6]. Brinjal line DBWR 190-44-3-2-5 yield 46.78 t/ha rich in total phenolics 46.58 mg GAE/100g. Among Carrot hybrids, DCatH 9139 for Potassium(441.72 mg/100g), DCatH 533 for Calcium(120.57 mg/100g), DCatH 9800 for Iron(512.62 µg/g), DCatH 739 for Zinc(43.71 µg/g) and Copper(12.06 µg/g) [6].

In 2021, IARI reported Brinjal variety DBHR-25407 with anthocyanins 168.85 mg/100g, DBHR-25 with total phenolics 182.79 mg GAE/100g, best hybrid was NDB 25 with antioxidant activity CUPRAC 73.63 and FRAP 81.4 mg GAE/100g respectively. Ascorbic acid was highest in variety G164 2.77 mg GAE /100 g [7].

In 2022, IARI identified Pusa golden cherry tomato 2 and Pusa tomato 1 promising for cultivation. Pusa Prasanskrit for suitable for protected cultivation as well as open field conditions. Pusa Cocktail suitable for high nutrition value and shelf life, and maximum yield Pusa Rakshit 17 q/100 m^2 [8]. Among Carrot hybrids, DCatH 9837 for total carotenoids(79.04 µg/g), Lycopene(42.07 µg/g), β-carotene(33.84 µg/g) and DCatH 736 for total antioxidant activity(16.33 mg GAE/100 g) [8].

The references mentioned above emphasize and draw attention to the nutritional values of food resources. Also, the production data reflects the higher interest & inclination of the Government of India (GoI) on the importance of antioxidants in food supplements in the well-being of its citizens. The elevated production of vegetables will make it easily available to people. With the awareness and selection of nutritional foods rich in oxidants and this new approach to diet and health, steps towards a healthier and happier life are underlined.

PROBLEMS TO BE INVESTIGATED

Antioxidants are an absolute must for a healthy and balanced diet. These essential nutrients are found in almost every food, with vegetables being one of the most abundant sources. The benefits of antioxidants in vegetables such as Tomato (*Solanum lycopersicum*), Spinach (*Spinacia oleracea*), Gandhari saag (*Amaranthus viridis*), Beng saag (*Centella asiatica*) [9], Phutkal (*Ficus geniculata*), Rugra (*Lycoperdon spp*), Mushroom (*Agaricus bisporus*), Bamboo shoots (*Phyllostachys edulis*), Taro (*Colocasia esculenta*), Carrot (*Daucus carota*), cannot be overstated. People are unaware of the dietary benefits of these foods. Occasionally, these foods are taken but their regular consumption may be encouraged because of their nutritional benefits. The habit of consuming these foods when present in seasons should be encouraged and there is a need for time to address and communicate with the masses. Ascorbic acid, a crucial antioxidant, is known for its therapeutic properties. It plays a pivotal role in activating the immune response, enhancing iron absorption, promoting collagen biosynthesis, and preventing the clotting of blood vessels. The purest form of Ascorbic Acid (AA) is Vit-C [10]. However, it is important to note that Ascorbic Acid is highly susceptible to oxidation, which can be accelerated by exposure to heat, light [11], and heavy metal cations where the oxidation occurs via a free radical chain reaction involving initiation, propagation, branching and termination steps [12] [13] .

To ensure the highest quality of vegetables like tomato, beans, potato, spinach, kacchu, beng saag, mushroom, phutkal, etc. in Jharkhand, it is essential to measure the quantity and quality of antioxidants present in foodstuffs. Therefore, it is of utmost importance to consume a variety of vegetables to maintain healthy and balanced diet rich in antioxidants.

The antioxidants capacity of above-mentioned foods will be quantified. Identification of antioxidants, their thermal stability, effect of acid and base and their effectiveness

on skin, intestine, and stomach will be studied. This work is going to explore the comparative differences of these components and by knowing these facts, one can decide what component should be included in their food. Its industrial/commercial uses will be explored.

OBJECTIVE OF THE INVESTIGATION AND MOTIVATION

- Identification of the antioxidants in leafy vegetables (Tomato, Beng saag, Gandhari saag, Phutkal) and underground modifications (Rugra, Mushroom, Kacchu, Bamboo shoots).
- Determine the antioxidant capacity.
- Anti-ageing properties.
- Medicinal effectiveness of vegetables.
- Finding the nutritional components such as carbohydrates, vitamins, proteins, fiber, etc.
- Physiochemical study of selected vegetables.
- Study the stability of antioxidants in Thermal / pH variations & their activities in association with others.
- The proposed work is motivated by the potential benefits of antioxidants by observing the nutritional importance of vegetables.

HYPOTHESIS

In the current study, we hypothesize that leafy vegetables (Tomato, Beng saag, Gandhari saag, Phutkal) and underground modifications (Rugra, Mushroom, Kacchu, Bamboo shoots) are highly antioxidant, anti-aging, and have medicinal properties. So, we will quantify the constituents and their properties.

RESEARCH DESIGN AND METHODOLOGY

- For this research project, we aim to extract the total antioxidant content of various leafy vegetables and underground modifications.
- In this research the total antioxidant will be extracted from followings:
  i) Leafy vegetables (Tomato, Beng saag, Gandhari saag, Phutkal)
  ii) Underground modification used as vegetables (Rugra, Mushroom, Taro, Bamboo shoots)

- There are a few common methods to determine antioxidant capacity like Oxygen Radical Absorbance Capacity (ORAC) assay, 2,2'-diphenyl-1-picrylhydrazyl (DPPH) assay, Ferric reducing antioxidant power (FRAP) assay, Cupric reducing antioxidant capacity (CUPRAC) assay and others.
- In this work three methods to determine the antioxidant levels may be used: FRAP assay, PFRAP assay, and DPPH assay. The results of all three methods will be compared with each other.
    1. In DPPH assay 2,2'-diphenyl-1-picrylhydrazyl radical is used which is a stable free radical due to the delocalization of the spare electron on the whole molecule [14] [15] . This method is used to measure the ability of compounds to act as free radical scavengers or hydrogen donors, to evaluate antioxidant activity and quantify antioxidants. This assay is based on measuring the decrease in absorbance of DPPH radical as a result of reaction with antioxidants. Antioxidants with weak A-H bonding react with stable free radical $DPPH^{\cdot}$ causing discoloration of molecules [16] [17].
    2. Potassium ferricyanide reducing power (PFRAP) assay is based on the reduction of Fe^{3+} to Fe^{2+} in the presence of antioxidants [18]. The compound with antioxidant activity reacts with potassium ferricyanide to form potassium ferrocyanide. Then it reacts with $FeCl_3$ to form an intense Prussian blue colour complex having absorbance at 700nm. The amount of complex formed indicates the reducing power of antioxidants [19].
    3. The Ferric reducing antioxidant power (FRAP) method is a technique used to measure the total antioxidant quality of food. It works by measuring the reduction of ferrous ammonium sulfate from a ferric to a ferrous state, which can be correlated with the amount of antioxidants present in the food. This measurement is done spectrophotometrically at 593 nm under optimal conditions. [20] [21].

Data from other sources will be compared with the data generated in our findings.

TOOLS TO BE USED FOR THE COLLECTION OF DATA

A. <u>Primary Source</u>

The key to unlocking the mysteries of the world lies in the data we collect and the primary source of this data is through experiments and observations. By extracting valuable insights from these observations, we gain a better understanding of the world

around us. So let us continue to push the boundaries of scientific discovery by utilizing the power of experimentation and observation.

B. Secondary Source

Secondary sources for research can be found in journals, books, and online data available on the internet.

SIGNIFICANCE OF THE WORK

Comparing the different sources and amounts of antioxidants found in various vegetable forms can help us classify them according to their antioxidant quality. This can help dispel myths about food quality and consumption and ultimately promote the well-being of society. It could also serve as a handy reference guide [22] [23].

RELEVANCE TO WORK

By evaluating both qualitative and quantitative measures of the overall antioxidant capacity of popular vegetables in Jharkhand, we can unlock the potential health benefits of certain vegetables in the state. This study presents a new and innovative approach to our current knowledge and has the potential to benefit the community's overall well-being. Let's explore the quality and significance of Jharkhand's vegetables to promote a healthier lifestyle for all [24].

FUTURE WORK

Antioxidants have captured the attention of the entire world for their ability to reduce the risk of acidity, ulceration, and chronic gastrointestinal disorders. Researchers are now focused on identifying and quantifying the naturally occurring oxidants and their sources, making it a widely studied topic in present-day research. Over the last decade, thousands of research articles have been published on the identification, estimation, and synthesis of antioxidants, due to their wide social relevance. The research being pursued in this area is a never-ending field, with a horizon for further exploration. This research work is expected to continue, leading to a bright future where we can effectively reduce the risk of gastrointestinal disorders and improve the quality of life for millions of people.

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